Industrial Exposure and Control Technologies for OSHA Regulated Hazardous Substances

U.S. Department of Labor
Elizabeth Dole, Secretary
March 1989

Volume I of II
Substances A-I

Occupational Safety and Health Administration
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Ammonia
(CAS NUMBER: 7664-41-7)

SYNONYMS

Ammonia gas/Ammonium amide /Spirit of hartshorn/Am-fol/Ammoniac (French)/Ammoniaca (Italian)/Ammoniak (German) /Amoniak (Polish) /Anhydrous ammonia /Ammonia solution, with > 44% ammonia

TRADE NAMES

Nitro-sil; Refrigerant R717.

DESCRIPTION OF SUBSTANCE

Anhydrous ammonia is a clear, colorless gas with a characteristic, intensely irritating odor. It is very soluble in water, alcohol, and ether. [ACGIH, P. 27, 1986]

HEALTH EFFECTS

Ammonia vapors cause irritation of the eyes and respiratory tract. High concentrations cause conjunctivitis, laryngitis and pulmonary edema, possibly accompanied by a feeling of suffocation. Contact with the skin causes burns and blistering. If absorption becomes extensive, coma may arise preceded by convulsions. Ammonia has a greater tendency than other alkalies to penetrate and damage the eye, and to cause cataracts. [EPA, 1986]
Iritis may be accompanied by hypopyon or hemorrhages, extensive loss of pigment, and severe glaucoma. [GRANT. TOX OF THE EYE 1974]
Ammonia ingestion produces high incidence of ulcerative esophagitis with late resulting strictures. Gastric, duodenal, and jejunal stenosis have also resulted. Unrecognized late strictures may be confused with malignant growths. [GOSSELIN. CTCP 5TH ED. 1984]
Worker complained of chronic cough and increased dyspnea on effort. Bilateral infiltrates seen on chest x-ray and lung function indices reflected ventilatory and diffusion abnormalities. After three years away from ammonia exposure, worker had persistent evidence of pulmonary damage. [HAMILTON. INDUS TOX 3RD ED 1974]
Six volunteers inhaled ammonia at 21 and 35 mg/m3 for 10 minutes. Five reported faint to moderate irritation and 1 reported no irritation at 35 mg/m3. Another group was exposed for 5 minutes to 22, 35, 50 and 94 mg/m3. The 94 mg/m3 caused eye irritation with lacrimation, nose and throat irritation and in 1 volunteer, chest irritation. [PATTY. INDUS HYG & TOX 3RD ED VOL2A,2B,2C 1981-82]
Toxic doses of ammonia acutely affect cerebral energy metabolism and this effect is preferentially localized at base of brain. [ACGIH. TLVS. 4TH ED & SUPPL. 1980]

Inhalation causes secretion of saliva and retention of urine. [BRAKER W, MOSSMAN A; MATHESON GAS DATA BOOK 6TH ED P.24 (1980)]
Swallowing of the liquid results in severe corrosive action to the mouth, throat, and stomach. [BRAKER W, MOSSMAN A; MATHESON GAS DATA BOOK 6TH ED P.24 (1980)]
Two cases of possible sensitization to ammonia have been reported. The first man developed urticaria on 3 occasions when exposed to ammonia gas coming off an ammonium hydroxide solution at his workplace, but the condition cleared up when he stayed away from work. The second worker reported breaking out with hives once at work and twice when he was riding in a car with workers who had been exposed to ammonia. [MORRIS GE; ARCH IND HEALTH 13:480 (1956) AS CITED IN NIOSH; CRITERIA DOCUMENT: AMMONIA P.34 (1974) DHEW PUB. NIOSH 74-136]
Hyperammonemic-associated encephalopathy developed in an adult receiving essential amino acids. Evidence that her encephalopathy was related to her hyperammonemia included (1) elevated cerebral spinal fluid glutamine and serum ammonia levels, (2) the absence of any other drug or metabolic cause of encephalopathy, and (3) resolution of her encephalopathy and abnormal ammonia levels with discontinuation of the hyperalimentation. The serum ammonia levels of patients receiving essential amino acid fluid should be monitored. If the levels remain elevated or if toxicity develops, consideration should be given to switching to an alternate fluid. [GRAZER RE ET AL; ARCH INTERN MED 144(11): 2278-2279 (1984)]
The effect of various ammonia concentrations in an enclosed atmosphere on man's adrenocortical system was investigated in five experiments on 20 young healthy test subjects. The most pronounced changes in the adrenocortical system developed when the ammonia content was 5 mg/m3. [KALANDAROV S ET AL; KOSM BIOL AVIAKOSM MED 18(3): 75-77 (1984)]
The effect of addition of ammonia to cultures of human blood lymphocytes was studied. The concentration of ammonia in the lymphocyte cultures represented normal (0.01-0.5 mg/dl), subtoxic (0.5-1 mg/dl), and toxic (1-10 mg/dl) concentrations of ammonia in blood. Viability of the lymphocytes and their mitogenic reactivity were measured. In general, 1.0 and 10 mg/dl of ammonia (toxic concentration) affected viability and mitogenic responsiveness of all lymphocytes. [KLUCINSKI W AND TARGOWSKI SP; IMMUNOPHARMACO]
Detection level for humans is less than 5 ppm.

TOXICITY/EXPOSURE LIMITS

NFPA RATING -

	(Liquified)		(Gas)	
Health	- 3	Severe	2	Moderate
Flammability	- 1	Slight	1	Slight
Reactivity	- 0	None	0	None

TOXICITY HAZARD RATING - Acute and chronic local: skin 3-2; mucous membranes 3-2; eyes 3-2. Acute and chronic systemic; ingestion 3-2; inhalation 3-2; skin 3-2. 3=High: may cause death

or permanent injury after exposure to small quanitities. 2=Moderate: may involve both irreversible and reversible changes not severe enough to cause death or permanent injury. [SAX. DANGER PROPS INDUS MATER 6TH ED, P. 257, 1984]

IMMEDIATELY DANGEROUS TO LIFE OR HEALTH - 500 ppm [MACKISON. NIOSH/OSHA GUIDE CHEM HAZARDS 1980]

OSHA PEL -
35.000 ppm, 27.000 mg/m3;STEL

ADOPTED ACGIH/TLV - 25.000 ppm, 18.000 mg/m3;TWA
35.000 ppm, 27.000 mg/m3;STEL

NIOSH/REL -
50.000 ppm, 35.000 mg/m3;STEL - 5 minutes

INDUSTRY USE DATA

Twenty-five percent of ammonia produced is used as a direct application fertilizer; intermediate uses include 10% used to make urea fertilizer; 19% for ammonium nitrate fertilizer; 18% for all other fertilizers; 4% for ammonium nitrate-based commercial explosives; 7% for major fiber and plastic intermediates, and 14% for all other applications. [SRI]
Also used as a bactericide. [USEPA/ PESTICIDE INDEX 1985]
Manufacture of nitric acid, explosives; in refrigeration and chemical industry. [MERCK INDEX. 10TH ED 1983]
Pharmaceutical processes as mild alkalizer. [OSOL. REMINGTON'S PHARM SCI 16TH ED 1980]
Preharvest cotton defoliant. [FARM CHEM HDBK 1986]
Chemical intermediate for urea, ammonium nitrate, ammonium salts, adipic acid for nylon, hexamethylenediamine for nylon, acrylonitrile for fibers and plastics, caprolactam for nylon, isocyanates for plastics; direct application fertilizer; numerous miscellaneous applications. [SRI]
Used in manufacture of hydrazine, pesticides, and detergents. [PATTY. INDUS HYG & TOX 3RD ED VOL 2A,2B,2C 1981-82]
Added to public water supply to aid chlorination processes. [MERCK INDEX. 10th ED 1983]
Removing stains, bleaching, calico printing, extracting plant colors (cochieal, archil, etc.) and alkaloids. [NRC. DRINKING WATER & HEALTH VOL2 1980]
Ammonia, or dissociated ammonia, is used in such metal treating operations as nitriding, carbo-nitriding, bright annealing, furnace brazing, sintering, sodium hydride descaling, atomic hydrogen welding, and other applications where protective atmospheres are required. Dissociated ammonia is also used as a convenient source of hydrogen for the hydrogenation of fats and oils. Through the controlled combustion of dissociated ammonia in air, a source of pure nitrogen is achieved. The petroleum

industry utilizes anhydrous ammonia in neutralizing the acid constituents of crude oil and in protecting equipment such as bubble plate towers, heat exchangers, condensers, and storage tanks from corrosion. Ammonia is used in extracting such metals as copper, nickel, and molybdenum from their ores. 24 Diluted solution of ammonia in water is used as a common household cleansing agent.]
The substitution of ammonia for calcium is used in the bisulfite pulping of wood. This improves the yield and quality of the pulp. Ammonia is also used as a solvent for casein in the coating of paper. Ammonia is used in the rubber industry for stabilization of raw latex to prevent coagulation during transportation and storage. Ammonia is used as a catalyst in phenol-formaldehyde condensation and also in urea-formaldehyde condensation to make synthetic resin. [BRAKER W, MOSSMAN A; MATHESON GAS DATA BOOK 6TH ED P.24 (1980)]
Most of ammonia produced worldwide is used for fertilizer. Much of it is applied by injection of anhydrous gas directly into soil. [PATTY. INDUS HYG & TOX 3RD ED VOL 2A,2B,2C 1981-82]
Ammonia may be added to water before (preammoniation) or after (postammoniation) addition of chlorine. Preammoniation can prevent formation of tastes and odors that are caused by reaction of chlorine with phenols and other substances. Postammoniation is most often used in ammonia-chlorine water treatment process. [FARM CHEM HDBK 1986]
Used on grapefruit, lemons and oranges to control fungal growth during warehousing. USDA has now requested that ammonia used as preservative in high-moisture corn be exempted from requirement of a tolerance. [PATTY. INDUS HYG & TOX 3RD ED VOL 2A,2B,2C 1981-82]
Used as developer in photocopying processes blueprint and diazo, it may be released into workplace. [NRC. DRINKING WATER & HEALTH VOL2 1980]
Fertilizer; 2872 explosives; synthetic fibers; used in phosphate ore flotation; production of uranium concentrate; refrigeration systems.

NIOSH 1982 NATIONAL OCCUPATIONAL EXPOSURE SURVEY

SIC CODE	INDUSTRY NAME	TOTAL ON PAYROLL	TOTAL EXPOSED	PERCENT EXPOSED
7332	BLUEPRINTING AND PHOTOCOPYING	28	12	42.86
7349	BUILDING MAINTEN. SERVICES NEC	10,731	3,975	37.04
2833	MEDICINALS AND BOTANICALS	2,347	655	27.91
2873	NITROGENOUS FERTILIZERS	103	28	27.18
2874	PHOSPHATIC FERTILIZERS	330	72	21.82
2992	LUBRICATING OILS AND GREASES	546	114	20.88
3622	INDUSTRIAL CONTROLS	4,083	800	19.59
2911	PETROLEUM REFINING	10,713	1,480	13.81
3398	METAL HEAT TREATING	242	33	13.64
2813	INDUSTRIAL GASES	100	13	13.00
2022	CHEESE, NATURAL AND PROCESSED	906	112	12.36

2038	FROZEN SPECIALTIES	1,333	141	10.58
3339	PRIMARY NONFERROUS METALS, NEC	160	15	9.38
2822	SYNTHETIC RUBBER	488	44	9.02
2253	KNIT OUTERWEAR MILLS	7,386	577	7.81
4911	ELECTRIC SERVICES	7,193	542	7.54
2084	WINES/BRANDY & BRANDY SPIRITS	150	11	7.33
2082	MALT BEVERAGES	6,886	480	6.97
4111	LOCAL AND SUBURBAN TRANSIT	115	8	6.96
2077	ANIMAL & MARINE FATS AND OILS	89	6	6.74
2819	IND. INORGANIC CHEMICALS, NEC	11,107	747	6.73
3825	INSTR. TO MEASURE ELECTRICITY	18,445	1,107	6.00
3471	PLATING AND POLISHING	1,512	89	5.89
2024	ICE CREAM AND FROZEN DESSERTS	168	9	5.36
7333	COMMERCIAL PHOTOGRAPHY AND ART	377	20	5.31
2241	NARROW FABRIC MILLS	361	19	5.26
3111	LEATHER TANNING AND FINISHING	474	24	5.06

NIOSH 1972 NATIONAL OCCUPATIONAL HAZARD SURVEY

SIC CODE	INDUSTRY NAME	TOTAL ON PAYROLL	TOTAL EXPOSED	PERCENT EXPOSED
5921	LIQUOR STORES	494	384	77.73
5421	MEAT AND FISH (SEA FOOD) MARK	8	6	75.00
4222	REFRIGERATED WAREHOUSING, NEC	344	227	65.99
5541	GASOLINE SERVICE STATIONS	382	251	65.71
7349	MISCELLANEOUS SERVICES TO BUI	665	361	54.29
0912	FINFISH	37	17	45.95
2833	MEDICINALS AND BOTANICALS	618	265	42.88
2843	SURFACE ACTIVE AGENTS	339	139	41.00
2097	MANUFACTURED ICE	83	32	38.55
2299	TEXTILE GOODS, NEC	61	22	36.07
1743	TERRAZZO, TILE, MARBLE, MOSAI	129	40	31.01
7631	WATCH, CLOCK, AND JEWELRY REP	25	7	28.00
8071	MEDICAL LABORATORIES	111	26	23.42
2024	ICE CREAM AND FROZEN DESSERTS	67	15	22.39
7933	BOWLING ALLEYS	174	38	21.84
2879	AGRICULTURAL CHEMICALS, NEC	56	12	21.43
3339	PRIMARY NONFERROUS METALS, NE	528	110	20.83
7231	BEAUTY SHOPS	63	13	20.63
2819	INDUSTRIAL INORGANIC CHEMICAL	2,679	535	19.97
2262	FINISHING PLANTS, SYNTHETICS	936	186	19.87
3399	PRIMARY METAL PRODUCTS, NEC	230	41	17.83
2432	VENEER AND PLYWOOD	827	142	17.17
6513	APARTMENT BUILDING OPERATORS	797	129	16.19
2891	ADHESIVES AND GELATIN	50	8	16.00
8911	ENGINEERING & ARCHITECTURAL S	1,001	158	15.78
7549	AUTOMOBILE SERVICES, NEC	39	6	15.38
2591	VENETIAN BLINDS AND SHADES	482	70	14.52
3262	VITREOUS CHINA FOOD UTENSILS	14	2	14.29
2871	FERTILIZERS	306	43	14.05
3581	AUTOMATIC MERCHANDISING MACHI	396	50	12.63
3021	RUBBER FOOTWEAR	540	68	12.59

2026	FLUID MILK	2,060	258	12.52
5451	DAIRY PRODUCTS STORES	88	11	12.50
7539	AUTOMOBILE REPAIR SHOPS, NEC	32	4	12.50
2899	CHEMICAL PREPARATIONS, NEC	1,050	130	12.38
3111	LEATHER TANNING AND FINISHING	1,522	177	11.63
2818	INDUSTRIAL ORGANIC CHEMICALS	1,362	152	11.16
2834	PHARMACEUTICAL PREPARATIONS	993	103	10.37
2841	SOAP AND OTHER DETERGENTS	536	54	10.07
6024	STATE BANKS, NOT FED. RES., N	40	4	10.00
7261	FUNERAL SERVICE AND CREMATORI	142	14	9.86
2851	PAINTS AND ALLIED PRODUCTS	2,299	226	9.83
5912	DRUG STORES AND PROPRIETARY S	275	27	9.82
3576	SCALES AND BALANCES	95	9	9.47
2831	BIOLOGICAL PRODUCTS	7,046	655	9.30
3911	JEWELRY, PRECIOUS METAL	622	57	9.16
6512	NONRESIDENTIAL BUILDING OPERA	427	39	9.13
2643	BAGS, EXCEPT TEXTILE BAGS	920	83	9.02
4952	SEWERAGE SYSTEMS	34	3	8.82
5462	RETAIL BAKERIES--BAKING AND S	35	3	8.57
2647	SANITARY PAPER PRODUCTS	227	19	8.37
2815	CYCLIC INTERMEDIATES AND CRUD	160	13	8.12
5411	GROCERY STORES	2,554	197	7.71
7622	RADIO AND TELEVISION REPAIR	108	8	7.41
4422	COASTWISE TRANSPORTATION	796	57	7.16
7942	PUBLIC GOLF COURSES	28	2	7.14
7391	RESEARCH & DEVELOPMENT LABORA	938	64	6.82
4931	ELECTRIC AND OTHER SERVICES C	681	45	6.61
8999	SERVICES, NEC	95	6	6.32
2793	PHOTOENGRAVING	148	9	6.08
2256	KNIT FABRIC MILLS	4,110	249	6.06
3471	PLATING AND POLISHING	722	42	5.82
5077	AIR CONDITIONING AND REFRIGER	227	13	5.73
4923	GAS TRANSMISSION AND DISTRIBU	210	12	5.71
3356	NONFERROUS ROLLING AND DRAWIN	484	27	5.58
5812	EATING PLACES	3,060	170	5.56
3559	SPECIAL INDUSTRY MACHINE, NEC	498	27	5.42
2015	POULTRY DRESSING PLANTS	1,128	61	5.41
1389	OIL AND GAS FIELD SERVICES, N	280	15	5.36
8061	HOSPITALS	21,819	1,135	5.20
2992	LUBRICATING OILS AND GREASES	543	28	5.16
3554	PAPER INDUSTRIES MACHINERY	718	37	5.15

OSHA/EXPOSURE DATA

NONE

ENGINEERING CONTROLS

General ventilation; local exhaust ventilation; hood; enclosure of process or worker, as needed; air cleaning equipment. These are methods for prevention of acute exposure to ammonia gas through timely detection and control. Company operation was poultry processing; ammonia refrigeration system; freezer coil. Hazard level limitation through use of ammonia detection system with alarms, in freezer; placement of cut-off valves to coils

outside freezer. Detect and stop leak without freezer entry; limit volume of gas released into work areas. Honeywell manufactures an ammonia detection system for freezers. [HAZARD ABATEMENT FILE]

PERSONAL PROTECTIVE EQUIPMENT

Avoid bodily contact with the material. Wear boots, protective gloves, and gas-tight goggles. Do not handle broken packages without protective equipment. Wash away any material which may have contacted the body with copious amounts of water or soap and water. If contact with the material anticipated, wear full protective clothing. [(C)AAR, 1986]
Employees should be provided with & required to use impervious clothing, gloves, face shield (8-inch min), & other appropriate protective clothing necessary to prevent skin contact. They should be provided with & required to use splash-proof safety goggles. [NIOSH OSHA. OCCUPAT HEALTH GUIDE CHEM HAZARDS. 1981]
Ammonia: Chemical protective clothing composed of butyl rubber, natural rubber, neoprene, nitrile rubber, and polyvinyl chloride may be used since data suggest that breakthrough times are approximately an hour or more. Viton is not recommended for use since data (usually from immersion tests) suggest that breakthrough times are less than one hour. [EPA, 1986]
Respiratory protection should be as follows: Up to 300 ppm: any chemical cartridge respirator with cartridge(s) providing protection against the compound of concern. Substance reported to cause eye irritation or damage; may require eye protection. Up to 500 ppm: any supplied-air respirator or powered air-purifying respirator with cartridge(s) providing protection against the compound of concern; any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted canister providing protection against the compound of concern; or any self-contained breathing apparatus. Substance reported to cause eye irritation or damage; may require eye protection. Emergency or planned entry in unknown concentration or IDLH conditions: any self-contained breathing apparatus with full facepiece and operated in a pressure-demand or other positive pressure mode or any supplied-air respirator with a full facepiece and operated in pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus and operated in pressure-demand or other positive-pressure mode. Escape: any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted canister providing protection against the compound of concern or any appropriate escape-type self-contained breathing apparatus. [NIOSH: POCKET GUIDE TO CHEMICAL HAZARDS P. 51 (1987) DHEW (NIOSH) PUB NO. 85-114]

STORAGE

Protect against physical damage. Outside or detached storage is preferred. Inside storage should be in a cool, well-ventilated, non-combustible location, away from all possible sources of ignition. Separate from other chemicals, particularly oxidizing

gases, chlorine, bromine, iodine, and acids. [ACGIH, P. 49-16, 1986]